Claims

We claim:

1. A microphone system for communication devices comprising:

   a. a first microphone element;

   b. a second microphone element positioned near the first microphone element; and

   c. a signal flow processor electrically connected to the first and second microphone elements;

wherein the signal flow processor provides an electrical time delay to the first microphone element and a compatible amplitude gain to the second microphone element and wherein the signal flow processor subtracts the outputs of the first and second microphone elements to create a null that reduces external acoustic coupling.

2. The microphone system of claim 1, wherein the first and second microphone elements each comprise an omnidirectional microphone element.

3. The microphone system of claim 1, wherein a first input sound port leads into the first microphone element and a second input sound port leads into the second microphone element.

4. The microphone system of claim 3, wherein the first and second input sound ports each comprise a sound input port of a mobile phone.

5. The microphone system of claim 4, wherein the mobile phone comprises a receiver positioned and located closer to the first input sound port than the second input sound port.

6. The microphone system of claim 5, wherein the signal flow processor makes the amplitude gain equal to unity and the time delay is selected from a range between 0 and a value

equal to d_2/c, wherein the variable "d_2" equals the distance between the first and second sound ports and the variable "c" equals approximately the speed of sound.

7. The microphone system of claim 5, wherein the electrical time delay ("τ") is equal to $\tau = (w-u)/c$, wherein the variable "w" equals the distance between the receiver and the second sound port, the variable "c" equals approximately 345,000 millimeters per second, and the variable "u" equals $\surd[w^2 + d_2^2 - 2\ d_2\ w\ \cos(\kappa - \Psi)]$ with the variable "d_2" being equal to the distance between the first and second input sound ports, with the variable "κ" being equal to the angle of an ear reference point adjacent to the receiver and the second input sound port, and with the variable "Ψ" being equal to the angle of the first input sound port and the second input sound port.

8. The microphone system of claim 7, wherein compatible amplitude gain ("Gm1") is equal to Gm1 = (w/u).

9. The microphone system of claim 3, wherein the first and second input sound ports each comprise an input sound port of a speakerphone, wherein the speakerphone comprises a loudspeaker with its center located and positioned closer to the first input sound port than the second input sound port.

10. The microphone system of claim 9, wherein the signal flow processor makes the amplitude gain equal to unity and the time delay is selected from a range between 0 and a value equal to d_2/c, wherein the variable "d_2" equals the distance between the first and second sound ports and the variable "c" equals approximately the speed of sound.

11. The microphone system of claim 10, wherein the electrical time delay("τ") is equal to $\tau = (w-u)/c$, wherein the variable "w" equals the distance between the center of the loudspeaker and the second sound port, the variable "c" equals approximately 345,000

millimeters per second, and the variable "u" equals $\sqrt{[w^2 + d_2^2 - 2\, d_2\, w \cos(\kappa - \Psi)]}$ with the variable "d_2" being equal to the distance between the first and second input sound ports, with the variable "κ" being identically equal to 0, and with the variable "Ψ" being equal to the angle of the first input sound port and the second input sound port.

12. The microphone system of claim 11, wherein compatible amplitude gain ("Gm1") is equal to Gm1 = (w/u).

13. A method for producing a null towards an acoustical driver of a communication device for reducing external acoustic coupling in the communication device, the method comprising the steps of:

a. providing a microphone system for telecommunications having

(i) a first microphone element having a first output; and

(ii) a second microphone element positioned near the first microphone element, the second microphone element having a second output;

(iii) a signal flow processor electrically connected to the first and the second microphone elements;

b. providing an electrical time delay to the first output;

c. providing an amplitude gain to the second output; and

d. subtracting the first output from the second output.

14. The method of producing a null of claim 13, wherein the method further comprises the step of providing a mobile phone having a first input sound port leading into the first microphone element, a second input sound port leading into the second microphone element, and wherein the acoustical driver comprises a receiver positioned and located closer to the first input sound port than the second input sound port.

15. The method of producing a null of claim 14, wherein the method further comprises the step of calculating the electrical time delay("τ") with the formula $\tau = (w-u)/c$, wherein the variable "w" equals the distance between the receiver and the second sound port, the variable "c" equals approximately 345,000 millimeters per second, and the variable "u" equals $\sqrt{[w^2 + d_2^2 - 2 d_2 w \cos(\kappa - \Psi)]}$ with the variable "d_2" being equal to the distance between the first and second input sound ports, with the variable "κ" being equal to the angle of an ear reference point that is adjacent to the receiver and the second input sound port, and with the variable "Ψ" being equal to the angle of the first input sound port and the second input sound port.

16. The method of producing the null of claim 15, wherein the method further comprises the step of calculating the compatible amplitude gain ("Gm1") with the formula Gm1 = (w/u).

17. The method of producing the null of claim 14, wherein the method further comprises the step of calculating the electrical time delay and compatible amplitude gain by driving the receiver with an electrical impulse and measuring the impulse response at both the locations of the first and second microphone element outputs.

18. The method of producing the null of claim 13, wherein the method further comprises the step of providing a speakerphone having a first input sound port leading into the first microphone element, a second input sound port leading into the second microphone element, and wherein the acoustical driver comprises a loudspeaker positioned and located closer to the first input sound port than the second input sound port.

19. The method of producing a null of claim 18, wherein the method further comprises the step of calculating the electrical time delay("τ") with the formula $\tau = (w-u)/c$, wherein the variable "w" equals the distance between the loudspeaker center and the second sound port, the

variable "c" equals approximately 345,000 millimeters per second, and the variable "u" equals $\sqrt{[w^2 + d_2^2 - 2 d_2 w \cos (\kappa - \Psi)]}$ with the variable "d_2" being equal to the distance between the first and second input sound ports, with the variable "κ" being identically equal to zero, and with the variable "Ψ" being equal to the angle from the second input sound port to the first input sound port.

20. The method of producing the null of claim 19, wherein the method further comprises the step of calculating the compatible amplitude gain ("Gm1") with the formula Gm1 = (w/u).

21. The method of producing the null of claim 18, wherein the method further comprises the step of calculating the electrical time delay and compatible amplitude gain by driving the loudspeaker with an electrical impulse and measuring the impulse response at both the locations the first and second microphone element outputs.

22. The method of producing the null of claim 14, wherein the electric time delay and compatible amplitude gain are each equal to a constant value with a finite number of discrete sub-bands across the communications band.

23. The method of producing the null of claim 18, wherein the electric time delay and compatible amplitude gain are each equal to a constant value within a finite number of discrete sub-bands across the communications band.

24. A method for producing a null towards an acoustical driver of a communication device for reducing external acoustic coupling in the communication device, the method comprising the steps of:

a. providing a microphone system for telecommunications having

(i) a first microphone element having a first output;

(ii) a second microphone element positioned near the first microphone element, the second microphone element having a second output;

(iii) a first signal flow processor electrically connected to the first and the second microphone elements;

(iv) a third microphone element having a third output;

(v) a fourth microphone element positioned near the third microphone element, the fourth microphone element having a fourth output;

(vi) a second signal flow processor electrically connected to the third and the fourth microphone elements;

(vii) a third signal flow processor electrically connected to the first and the second signal flow processors;

b. providing an electrical time delay to the first and the third outputs;

c. providing an amplitude gain to the second and the fourth outputs;

d. subtracting the first output from the second output to get a fifth output;

e. subtracting the third output from the fourth output to get a sixth output;

f. providing an electrical time delay to the fifth output;

g. providing an amplitude gain to the sixth output; and

h. subtracting the fifth output from the sixth output.

25. A method for producing a null towards an acoustical driver of a communication device for reducing external acoustic coupling in the communication device, the method comprising the steps of:

a. producing a first first-order difference with a first signal flow processor;

b. producing a second first-order difference with a second signal flow processor;

c. providing an electric time delay to the first first-order difference;

d. providing an amplitude gain to the second first-order difference; and

e. subtracting the first first-order difference from the second first-order difference.